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ABSTRACT

The report describes briefly two foundation-funded inservice training institutes for middle school teachers in Los Angeles (California) who have limited-English-speaking students in their classes. The first was designed to: (1) introduce teachers to the communicative approach to math and science instruction; (2) help develop instructional materials that encourage students to interact with the language of mathematics and science; (3) identify effective instructional and assessment practices for integrating content and language instruction; and (4) train selected teachers to become trainers and to assist in the design and implementation of the second institute. The project was linked to a federally funded program targeting English language acquisition and academic achievement, which allowed inclusion of social studies into the academic content. The first institute took place in November 1991, the second in May 1993. Participants were classroom teachers from seven schools. Evaluations of both institutes were very positive. Dissemination and networking efforts resulting from the project are summarized, and future directions in this kind of teacher training are outlined. Appended matter includes a project description and institute agendas and materials. (MSE)

INTEGRATING MATH AND SCIENCE WITH LANGUAGE INSTRUCTION
1991-1993

FINAL REPORT TO THE ARCO FOUNDATION
GRANT # GT90-756

CENTER FOR APPLIED LINGUISTICS
1118 22nd St, NW
Washington, DC 20037
August 1993

INTEGRATING MATH AND SCIENCE WITH LANGUAGE INSTRUCTION

Introduction

Improving the secondary and postsecondary completion rates in mathematics and science by ethnic, racial and linguistic minority students is a critical national need. Results from the National Assessment of Educational Progress studies in the 1980's (NAEP, 1986) showed that American students were doing less well on mathematical problems that required higher-order thinking than in the past. In *A Nation at Risk* (1983), the National Commission on Excellence in Education recommended that pre-high school curricula be designed to provide a sound base for the development of English language, computational, and problem-solving skills. A 1989 report by the National Research Council, *Everybody Counts*, clearly identified problems in mathematics education and proposed solutions. The National Council of Teachers of Mathematics (NCTM) began and completed a major overhaul of the K-12 mathematics curriculum using a grass-roots approach that provided ample opportunity for discussion and revisions of drafts of their standards (NCTM, 1989) from teachers, teacher educators, researchers, professors and policy-makers. In fact, the process by which NCTM developed their national standards has become the model according to which current standards projects in other disciplines (e.g., science, history, geography) have been designed. The NCTM standards recommended that teachers increase communication in their mathematics classes, make interdisciplinary connections, and develop problem-solving skills more fully. This, NCTM argued, should help students improve their comprehension and capabilities in mathematics.

From 1984-1990, the Center for Applied Linguistics (CAL) conducted a series of projects to address the need to improve math and science education for language minority students. CAL received funding to conduct these projects from the US Department of Education through the Fund for the Improvement of Postsecondary Education (FIPSE); the

Secretary's Discretionary Fund for Mathematics, Science, and Critical Foreign Languages; and the Office of Educational Research and Improvement (OERI); and from the Carnegie Corporation of New York and the Xerox Foundation. The projects carried on research and training initiatives across the United States which resulted in several important products: sets of interactive mathematics and science instructional materials; teacher guides and curricula; a teacher resource, *The Pre-Algebra Lexicon;* a training video, *Communicative Math and Science Teaching;* and teacher training and trainer of trainers packages for secondary content and language teachers. Through these projects CAL was able to establish a national database of math, science, and language educators interested in these issues and to network with professional organizations in these fields. CAL has been able to disseminate information about the work through journal articles, announcements, and conference presentations.

In these projects, we strove to foster cooperative relationships among mathematics, science, and language arts teachers in order to better educate students who were learning academic English. We were convinced that an interdisciplinary approach to training, one which incorporated the experience and content knowledge of mathematics and science educators as well as that of language arts educators, was needed to address this critical problem. The positive feedback we received from our efforts, and the interest we received from educators in mathematics, science, and language arts communities nationwide, convinced us to elicit support from the ARCO Foundation to continue our work.

Project Goals and Participants

In January 1991, the ARCO Foundation offered the Center for Applied Linguistics a grant to conduct two teacher training institutes with middle school teachers in the Los Angeles Unified School District. These institutes were to be designed following the successful trainer of trainers model that CAL had developed through earlier work. The project that resulted from the grant was "Integrating Math and Science with Language

Instruction." (See abstract in Appendix A.) The goals of the project were to (1) introduce teachers to the communicative approach to math and science instruction, (2) help them develop instructional materials that encourage students to interact with the language of mathematics and science, (3) identify effective instructional and assessment practices for integrating content and language instruction, and (4) train selected teachers to become trainers and to assist in the design and implementation of the second institute.

It was fortuitous that while CAL staff were making contacts with middle schools in Los Angeles, they were put in touch with a federally-funded Title VII program, the English Language Acquisition and Academic Achievement Program, operating in the target schools. CAL was able to link the ARCO-sponsored project to this Title VII program thus enhancing the impact by reaching a greater number of teachers and ensuring that the teachers received additional in-service opportunities that combined the objectives of the ARCO project with those of the Title VII program. In making this connection, CAL then included social studies teachers among the participants and was able to extend the work already done in math and science into this new subject area. Contacts were then made with individual teachers from six middle schools in Los Angeles: Adams, Belvedere, El Sereno, Griffith, Stevenson and Hollenbeck, who participated in the two ARCO-sponsored training institutes.

All of the participants in the training institutes were classroom teachers. Many of them were involved in graduate education classes at California State University, Los Angeles (CSULA), where they were getting master's degrees or certificates for teaching language minority students. These teachers, most of whom were content area teachers, were motivated to learn more about effective instructional practices for the language minority students who were taking their content area classes. In this way, the project did not target pre-service training as much as it targeted teachers in graduate degree programs. The connection to the pre-service curriculum has been more tangential. The project

consultant, Dr. Marguerite Ann Snow, is a faculty member at CSULA and has incorporated many of the concepts and activities presented in the workshops in her own courses.

Teacher Training Institutes

CAL organized and participated in two 2-day teacher training institutes, held on CSULA's campus. The first institute took place November 19-20, 1991 and was facilitated by Dr. Jodi Crandall of the Center for Applied Linguistics and Dr. Ann Snow of CSULA. (The agenda can be found in Appendix B.) Teams of teachers from the six schools attended this institute. On the first day, this workshop provided the rationale for integrating language and content instruction and highlighted successful instructional strategies and lesson planning approaches. The second day focused on cooperative learning techniques with language minority students and was led by a consultant who is an expert in cooperative learning and science, Dr. Mary Rivkin. Discussion of training plans for teachers and action plans for schools also took place.

The second institute was originally scheduled for May 1992, but the riots in Los Angeles in April of that year precluded the training from being implemented. It was rescheduled for May 19-20, 1993. During the intervening years, however, the teachers continued their training work with the Title VII project and several teachers were identified as potential teacher trainers. Some of the teachers had shifted schools during this time, so for the second institute, a seventh school was added to the pool, Rowan Middle School.

Before the May 1993 institute was planned, Dr. Snow and colleagues surveyed the teachers as to their needs and preferences for further training. In addition, the six teachers identified as trainers were asked to prepare presentations that would complement the overall goals of the institute. The teachers and trainers selected three categories of information: alternative assessment in content area classes with an emphasis on portfolios, techniques for teaching math and science to language minority students, and computer instruction for language minority students. (See Appendix C for agendas.)

The first day focused on assessment. To assist in the portfolio session, Dr. Anne Katz, who works with the Evaluation Assistance Center-West, was asked to present an overview of portfolio assessment, and two teacher trainers from Griffith Middle School shared their activities with portfolios. Deborah Short of CAL finished the first day with a session on other alternative assessment activities for math and science classes. For the second day, teachers were divided into two groups. Half attended the computer workshop that was facilitated by a professor from CSULA, Dr. James Wiebe. He was assisted by two teacher trainers: Maryann Kearns from Rowan Middle School, and Ed Shorer from El Sereno Middle School. The other half of the participants attended the math and science workshop led by Deborah Short with presentations by two teacher trainers, Bruce Gasser from Griffith Middle School and Jorge Estrada from Belvedere Middle School.

The evaluations from both institutes were very positive. Teachers appreciated the presentations by their colleagues, the hands-on activities and the practical applications of research theory that were shared. They encouraged the Title VII project to consider additional linkages with CAL in the future.

Dissemination

CAL thought it important to share information about this project to interested educators who were not involved, and also to share new information about other research with the participating teachers. CAL reached these objectives in several ways. First, the teacher training institutes were described in the Title VII program's newsletter which is sent to all schools in the program as well as the US Department of Education, other Title VII programs, and other educators on their mailing list. Second, an article describing funded content-based programs, written by the project consultant Dr. Snow, was published in the *CATESOL Journal*, April 1992. (See Appendix D for these.) Third, two other articles are in preparation about the project. One will be published in the *CAL Reporter* and the other will be submitted to the *CATESOL Newsletter*.

To share information with the participating teachers, CAL staff purchased resource and instructional materials for each school's teacher reference library. At the training institutes, CAL introduced these products to the teachers and allowed them to be previewed. The materials included: *English Skills for Algebra* (Crandall et al., 1989), *Science for Language Learners* (Fathman & Quinn, 1989), *How to Integrate Language and Content Instruction* (Short, 1991), *Communicative Math and Science: Video and Training Guide* (Center for Applied Linguistics, 1990), the *Pre-Algebra Lexicon* (Hayden & Cuevas, 1990), *Of the People: US History* (Short et al., 1992), *By the People, For the People: US Government and Citizenship* (Short et al., 1992), *Performance and Portfolio Assessment for Language Minority Students* (Pierce & O'Malley, 1992), *Teaching Science to English Learners, Grades 4-8* (Fathman, Quinn & Kessler, 1992), and *Cooperative Learning in the Secondary School* (Holt, Chips & Wallace, 1993). The Xerox Foundation provided some supplemental funds so sets of all these materials could be distributed to each school in the project.

Networking

Participation in the ARCO project has allowed CAL to develop relationships with several professional organizations concerned with the mathematics and science achievement of minority students. CAL has been a member of both the National Council of Teachers of Mathematics and the National Science Teachers Association. CAL staff have served on the Mathematical Sciences Education Board's working group, AIMM (Alliance to Involve Minorities in Mathematics), since 1990, participating in several task force meetings that resulted in such publications as *Making Mathematics Work for Minorities* (MSEB, 1990). CAL was also asked to participate in a symposium sponsored by the American Association for the Advancement of Science at their annual convention in February, 1993. At the symposium, "Application of Science Instruction, Research and Development for LEP Students to Instruction for All Students," CAL staff described the research conducted and

the teacher training implemented through projects such as the ARCO-sponsored one. The audience for this symposium included K-12 teachers and teacher educators. (The program announcement and handout for the presentation is found in Appendix E.) In addition, CAL staff have been reviewers for the science standards project, headed by National Committee on Science Education Standards and Assessment at the National Science Foundation. In all of these fora, CAL has had opportunities to raise the issues involved in providing math and science education to language minority students early in the overall planning processes.

Future Directions

This project, "Integrating Math and Science with Language Instruction," was successful in meeting its goals. Teachers were introduced to the communicative approach to math and science instruction and began developing instructional materials for their own classes that would encourage students to comprehend and practice using the language of mathematics and science. Effective instructional and assessment practices for integrating content and language instruction were identified, demonstrated and tried out. Finally, selected teachers were trained to work as teacher trainers and they helped design and facilitate sessions during the second institute.

Teacher training, where math, science and language teachers have opportunities to work together in teams and to take what they learn in an institute back to their schools, is a valuable process, but unfortunately is not a common occurrence. This ARCO-sponsored project was able to bring together these educators from different content areas and help them work in partnership, each member bringing unique experiences and backgrounds to the team. CAL would like to continue conducting this type of training with middle school teachers in the future. The teachers provided very positive comments about the training process and indicated a desire to participate in more professional development opportunities. CAL has been refining its training model over the past ten years and will continue to share it with interested educators. The ARCO-sponsored project has allowed

CAL to work with math, science and social studies teachers at the middle school level. Additional research in assessment techniques for courses that integrate language and content is needed in the near future.

Budget

The funds given to CAL through this ARCO grant #GT90-756 were completely dispersed through the life of the project. A full accounting of the costs incurred is provided in Appendix F.

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Appendix A

Center for Applied Linguistics

INTEGRATING MATH AND SCIENCE WITH LANGUAGE INSTRUCTION

A TEACHER EDUCATION PROJECT

With support from the ARCO Foundation, CAL is extending its work in the integration of language and content instruction to provide two institutes for teachers in the Los Angeles area. The first institute will be held during the fall of 1991. A second institute, partially staffed by teachers from the first institute, will be held in the summer of 1992.

The purpose of the institutes will be to provide teams of teachers from participating schools with curricula, materials, and techniques for teaching math and science with a communicative approach. This approach enables language minority students to participate in mainstream classes; it also helps ESL teachers to incorporate more academic content in their instruction.

This project is a continuation of eight years of research and materials development by CAL in integrated language and content instruction. The goal of this work is to help regular classroom teachers to meet the needs of language minority students, including those currently in ESL or bilingual education and those recently mainstreamed into all English medium instruction. CAL's work in this area has included:

- Investigation of the special problems language minority students face when presented by the language of mathematics;

- Development of curricula and materials to encourage students to interact using the language of mathematics and science;

- Development of assessment instruments to help teachers identify difficulties students face in using mathematics or science language;

- Identification of effective practices in integrating math, science, and language instruction and production of a teacher education videotape and training guide;

- Provision of a series of workshops and institutes in many parts of the country focusing on the communicative approach to teaching math and science; and

- National dissemination of information, curricula, materials, and training in the communicative approach to teaching math and science.

For further information contact: Dr. JoAnn Crandall, CAL, 1118 22nd Street, NW, Washington, DC 20037. 202-429-9292; fax - 202-659-5641.

Appendix B

Title VII Workshop for:

Math
Science
Social Studies

Instructional Strategies for Making Content Comprehensible for Language Minority Students
(Sheltered English Strategies)

Leaders

DR. ANN SNOW
DR. JODI CRANDALL

Tuesday, November 19th, 8:30-2:00
Wednesday, November 20th, 8:30-3:00

Cal State L.A.
Student Union
Room Alhambra B

Sponsored by: Center for Applied Linguistics & Arco Foundation

PARKING: Go to Visitors Information Kiosk for parking permit. Mention the seminar & your name.

CAL Center for Applied Linguistics

INTEGRATING LANGUAGE AND CONTENT INSTRUCTION: STRATEGIES FOR MAKING CONTENT COMPREHENSIBLE TO LANGUAGE MINORITY STUDENTS

LAUSD Title VII Workshop
(With funds provided by the ARCO Foundation & Xerox Foundation)

November 19-20, 1991

AGENDA

NOVEMBER 19, 1991	
8:30 - 9:00	Welcome Introductions
9:00 - 10:00	Issues in Integrating Instruction The Roles of Language, Culture, Content, Thinking Skills
10:00 - 10:15	Break
10:15 - 10:45	Models for Integrating Instruction
10:45 - 12:00	Instructional Strategies and Lesson Planning
12:00 - 1:00	Lunch
1:00 - 2:00	Texts and Materials Authentic and Adapted Texts
NOVEMBER 20, 1991	
8:30 - 10:30	Cooperative Learning and Integrating Instruction
10:30 - 10:45	Break
10:45 - 11:15	Issues of Assessment
11:15 - 12:00	Training Models and Agendas
12:00 - 1:00	Lunch
1:00 - 2:15	Action Plans
2:15 - 2:30	Break
2:30 - 3:00	Summary Next Steps

LANGUAGE AND CONTENT INTEGRATION THROUGH COOPERATIVE LEARNING

Center for Applied Linguistics
Los Angeles, CA
November 20, 1991

Mary Rivkin
Univ. Maryland
Baltimore Co.

Objectives:

1. Demonstrate the use of various cooperative learning strategies that are relevant to linguistic minority students.
2. Present a rationale for using cooperative learning with linguistic minority students.
3. Use a version of the structure Jigsaw to explore learning language through content(science).

Activities:

1. Introduction and classroom management.
2. Class building. Line Ups.
3. Team formation and team building.
4. Rationale for cooperative learning with LEP students (Roundtable)
5. Using content to teach language (Jigsaw).
6. Processing.
7. Evaluation.

"None of us is as smart as all of us."

Appendix C

Middle School TITLE VII Project

Presents

CAL/ARCO CONFERENCE

Center for Applied Linguistics funded by a grant from

ARCO

at

CSULA

Wednesday, May 19

8:30-3:30

Student Union Room 431

Topic: *Alternative Assessments, emphasis on portfolios*

Audience: All English, ESL, and content area teachers

Presenters: Ann Katz, Debbie Short, Laurie St. Gean

Thursday, May 20

8:30-2:30

King Hall Computer Labs

Topic 1: *Computers in the Language Arts classes*

Audience: English and ESL and others with computer interests Presenters: James Wiebe, Maryann Kearns and Ed Shorer

Student Union Room 431

Topic 2: *Activities, Strategies, & Principles to Make Math and Science Comprehensible*

Audience: Math and Science teachers and anyone else interested

Presenters: Debbie Short, Bruce Gasser, and Jorge Estrada

Center for
Applied
Linguistics

Los Angeles, CA

May 19, 1993

PORTFOLIO ASSESSMENT

Workshop Agenda

Presented by:
Anne Katz
EAC-West/ARC Associates
1212 Broadway, Suite 400
Oakland, CA 94612
(510) 834-9545

Agenda

1. Defining terms and asking questions: what are portfolios and how can they be used in the classroom?
2. Readings on classroom assessment
3. Answering your questions about portfolios
4. Dimensions to consider in developing a portfolio assessment system
5. Samples of portfolios

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Center for
Applied
Linguistics

Activities, Strategies and Principles to Make Math and Science Comprehensible

CAL/ARCO Sponsored LAUSD Title VII Workshop
Thursday, May 20, 1993

Deborah Short
Center for Applied Linguistics

Bruce Gasser and Jorge Estrada
Los Angeles Unified School District

Workshop Agenda

I. Overview: Integrated Language and Content Instruction
- curriculum reform
- professional organizations
- implementation issues
- guiding principles

II. The Language of Math and Science
- math and science word problems
- math features chart

III. Strategies and Activities for Making Math and Science Comprehensible
- demonstrations
- group activities
- lesson planning

IV. Assessment Issues

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Center for
Applied
Linguistics

Computers in Language Arts Classrooms: Content Area Programs

CAL/ARCO Sponsored LAUSD Title VII Workshop
Thursday, May 20, 1993

James Wiebe
CSULA

Maryann Kearns and Ed Shorer
Los Angeles Unified School District

Workshop Agenda

I. Introduction to using computers with ESL students

II. Demonstrations of effective programs

III. Hands-on activities
   Kids Pix
   Explorations
   Carmen San Diego

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Appendix E

TO: Program participants.
From: Frank X. Sutman FXJ

AAAS Annual Convention
Feb 11-16, 1993
Boston
23-4B

Saturday, 2:00pm *Hynes/303*

Applications of Science Instruction R&D for LEP Students to All Students

Organized by: **Frank X. Sutman** *(Elementary, Secondary & Informal Education, National Science Fdn)*

Sponsored by AAAS Section on Education

Results of recent research and development in science instruction and learning for limited English proficient (LEP) students has led also to advancement in knowledge for substantially improved science and basic skills instruction for all students. Implementation of these R&D results will enable language minority students, as well as other students, to increase their academic progress and to participate in greater numbers in the mainstream of the U.S. scientific enterprise.

Frank X. Sutman *(Elementary, Secondary & Informal Education, National Science Fdn)*
"Introduction and conclusion"

Matthew H. Bruce *(Dept of Curriculum & Instruction/Science, Temple Univ)*
"Field analysis of the IALS approach to basic science instruction"

This presentation describes the field research conducted in order to establish the validity of the Integrated Activity Learning Sequence (IALS) approach to instruction in science at the elementary school level, incorporating mathematics and language learning. The design of the field research is described and the outcomes are summarized, with special reference to the demonstrated potential for second language learners and the reactions of teachers who participated. Needs for further research are discussed and continuing activities in the project described.

Estrella Triana *(Proyecto Futuro, AAAS)*
"Lessons in science instruction for urban school teachers of LEP students"

Proyecto Futuro has combined development of instructional materials and teacher enhancement, based upon research findings, to strengthen local capacity for excellence in instruction for all students — especially Hispanic ones — at the K-8 level. The program emphasizes hands-on science activities, math skill development, and language proficiency development. The materials for teachers include a manual of activities in Spanish and English with a special section on Hispanic heritage, a videotape focusing on barriers Hispanics face in science and math, and a booklet featuring Hispanic role models. Materials developed for parents stress hands-on science and mathematics activities.

Richard P. Duran *(Graduate School of Education, Univ of California-Santa Barbara)*
"Comprehension and higher-order science skills among language minority students"

Cognitive science research has verified that intimate connections exist between competency to recognize science-related concepts in natural language and ability to accomplish problem solving involving concepts. Advances in cognitive theory and research have helped identify specific kinds of linguistic and cognitive processing demands that can affect students' ability to understand written expository texts and to reason from textual information. This talk will describe a research program investigating ways in which to simultaneously assess and train students' capacity to understand and reason with "if...then" English language constructions as might arise in English language science texts or other texts.

Beth Warren *(Technical Education Research Ctrs)*
"Scientific sense-making in language minority classrooms"

This talk will summarize findings from an NSF-funded project, "Studies of Sense-Making in Biology in Language Minority Classrooms." A general outline of the project, including its goals, methods, and theoretical perspective will be given. The speaker will then briefly describe what is meant by "scientific sense-making" and analyze an example of it in action in the classroom. A discussion of the implications of this approach for language minority students' learning in science will conclude the presentation.

Deborah Short *(English Language & Multicultural Education Div, Ctr for Applied Linguistics)*
"Integrating science and language: Research, materials, professional development"

The Center for Applied Linguistics has conducted research, training, and materials development in the areas of integrated language and science instruction for the past 10 years. This talk will describe some of the research findings and training practices that have helped science and language teachers provide better science instruction to language minority students.

Ronald W. Henderson *(Dept of Education & Psychology, Univ of California-Santa Cruz)*
"Developing mathematics motivation among students of Mexican descent"

This presentation examines processes by which parental, peer, and community factors influence motivation to pursue mathematics learning among students of Mexican descent. These issues are examined within cognitive social-learning and socio-cultural theoretical frameworks. Empirical findings are reported on the power of academic self-efficacy as a predictor of mathematics achievement among middle school students of Mexican descent. The nature of parental aspirations and expectations for their children's achievement and continuation in mathematics is then examined. Finally, the implications of parents' limited instrumental knowledge relevant to the pursuit of educational opportunities leading to careers requiring preparation in mathematics is discussed.

CAL
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Integrating Language and Content Instruction
Moving from ESL to the Mainstream

CAL's approach to integrating language and content has several guiding principles:

- Language and content teachers collaborate to produce authentic materials which accommodate students' varying language skills
- Thematic units provide a meaningful context
- Lesson plans incorporate content, language, and thinking skill objectives
- Instruction follows the Whole Language approach
- Cooperative learning and other techniques promote active student involvement
- Materials and techniques develop the academic language needed for school contexts
- Nontraditional techniques of assessment accommodate diverse learning styles and varying degrees of language skill

CAL has conducted research, materials development, and teacher training projects in integrated language and content instruction for nearly a decade.

Research

CAL has investigated special problems language minority students face with the language of mathematics and, by extension, the language of science.

CAL is currently conducting research into the language of social studies as well as strategies for using students as multicultural resources in both American and World social studies courses. This project is being carried out under the aegis of the National Center for Research on Cultural Diversity and Second Language Learning, housed at the University of California, Santa Cruz.

Teacher Training

CAL has identified effective practices for integrating math, science, or social studies with language instruction for K-12 math, science, and ESL/bilingual teachers. Many of these practices have been compiled in How to Integrate Language and Content: A Training Manual.

CAL has produced a training videotape, *Communicative Math and Science Teaching*, with an accompanying instructional guide.

CAL has developed and implemented a training package for in-service workshops and institutes in many parts of the country that introduces content teachers and language teachers to *integrated* language and content instruction. CAL has also conducted long-term (up to three years) training projects for school districts. Training projects such as these have been sponsored by the ARCO Foundation and the Carnegie Corporation of New York.

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Center for
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Linguistics

Integrating Language and Content Instruction
Moving from ESL to the Mainstream

GUIDING PRINCIPLES

Language and content teachers collaborate to produce authentic materials which accommodate students' varying language skills

Thematic units provide a meaningful context

Lesson plans incorporate content, language, and thinking skill objectives

Instruction follows the Whole Language approach

Cooperative learning and other techniques promote active student involvement

Materials and techniques develop the academic language needed for school contexts

Nontraditional techniques of assessment accommodate diverse learning styles and varying degrees of language skill

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